(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 690 322 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
26.01.2000 Bulletin 2000/04

(51) Int Cl.[7]: **G02B 6/42**

(21) Application number: **95110029.6**

(22) Date of filing: **27.06.1995**

(54) **Hermetically sealed optical fiber insert assembly**

Hermetisch abgeschlossene Einsatzstruktur für optische Faser

Structure d'insertion pour fibre optique fermée hermétiquement

(84) Designated Contracting States:
DE FR GB

(30) Priority: **29.06.1994 JP 14768394**

(43) Date of publication of application:
03.01.1996 Bulletin 1996/01

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(56) References cited:
EP-A- 0 337 141 DE-A- 3 741 773

- **PATENT ABSTRACTS OF JAPAN vol. 14 no. 150 (P-1025) [4093] ,22 March 1990 & JP-A-02 012114 (FUJITSU LTD.) 17 January 1990,**
- **PATENT ABSTRACTS OF JAPAN vol. 14 no. 98 (P-1011) [4041] ,22 February 1990 & JP-A-01 304406 (FUJITSU LTD.) 8 December 1989,**

EP 0 690 322 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a hermetically sealed optical fiber insert assembly for inserting an optical fiber into an optical package, such as an optical module, that accommodates therein optical elements.

Description of the Related Art

[0002] Typically, an optical module has accommodated therein various optical elements, such as a light-emitting element, a light-receiving element and a waveguide channel, that need an optical connection in the module to an inserted end of an external optical fiber, which is thus inserted through a package wall of the optical module. The optical elements tend to deteriorate in the air. Hence, the optical module is filled with an atmosphere such as nitrogen, and totally sealed, so that a hermetic sealing is necessitated for the insertion of the optical fiber also and operates as an important factor to a stable performance of the module.

[0003] For an increased hermeticity, a conventional sealing method has employed a glassed window, permitting an optical connection therethrough, without the need of directly inserting an optical fiber through a package wall. The window as well as the package wall is hermetically sealed. Free from a direct sealing of a fragile optical fiber, the conventional method is effective to provide a stable hermetic sealing. The method however needs an effective window area, resulting in an increased module size, and additional members such as a lens for the optical connection through the window.

[0004] Another conventional sealing method is proposed in the Japanese Patent Laid-Open Publication No. 2-12114 "FIBER INSERT TYPE PACKAGE AND HERMETIC SEALING METHOD THEREFOR", in which an optical fiber is inserted through a package wall, which is hermetically sealed by a soldering or with an adhesive.

[0005] Fig. 1 is a sectional view illustrating this conventional method. A package wall 27 of an optical module is formed with a through hole for providing therethrough a pipe 26 with a jacketted fiber 22 fitted therein. The jacketted fiber 22 is fixed to the pipe 26 with an adhesive 28 hermetically filled therebetween. An extension of a bare fiber 21 is hermetically fixed to a reduced end of the pipe 26 by use of a rosin-core solder 29 containing a cleaning flux to remove oxides in a skin region. A fixing ring 23 is soldered to the pipe 26 and the package wall 27. The soldering, designated at 30, provides a hermetic sealing between the package wall 27 and the pipe 26, but contains no cleaning flux, to prevent a migration of the solder. To this point, the soldering 29 between the pipe 26 and the bare fiber 21 is a preliminary process before the insertion of the pipe 26 to the package wall 27, and thus permits the flux to be washed off.

[0006] The latter conventional method needs the soldered ring 23 to provide a complete hermetic sealing. Therefore, the flux-free soldering 30 is needed to take competent measures such as by applying a pre-soldering to mating surfaces and securing a sufficient heating temperature and a sufficient heating time. However, the whole package wall 27 is not allowed to experience undue temperatures, and hence a heater is incorporated in the ring 23 for local heating.

[0007] Thus, the latter conventional method also is disadvantageous for example in that a special ring 23 is necessary, and that the fabrication process is long and troublesome. Further, the optical fiber fitted in the pipe 26 has a problem such that undue stresses in the fabrication process may cause a breakage in a boundary region between the bare fiber 21 fixed tight by the solder 29 and the jacketted fiber 21 held with the adhesive 28 to be relatively flexible.

[0008] A hermetically sealed optical fiber insert assembly as defined in the preamble of claim 1 is known from EP-A-0 337 141. In an assembly of this type a particular problem occurs when it is desired to fix the assembly by welding in a through hole of the wall of a package or casing. The welding process imposes significant thermal and mechanical stress to the components of the optical fiber insert assembly, especially to the boundary between the jacketed part and the strip part of the optical part fiber.

[0009] It is an object of the invention to provide an optical fiber assembly which is particularly suitable for being fixed by welding in a wall opening.

[0010] According to the invention the object is achieved by a hermetically sealed optical fiber insert assembly as defined in claim 1.

[0011] The dependent claims are directed to further preferred embodiments and improvements of the optical fiber assembly, and to a hermetically sealed optical fiber insert structure incorporating the optical fiber assembly.

[0012] According to the invention, the pipe member may comprise an inner pipe made of an Fe-Ni-Co alloy and an outer pipe made of a stainless steel.

[0013] According to the invention, therefore, a pipe member having an optical fiber inserted therein is hermetically fixed to a package member by welding, without using a fixing ring, thus permitting a relatively high hermeticity to be achieved in a facilitated fabrication process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The objects, features and advantages of the present invention will become more apparent from the consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a sectional view illustrating a conventional method;

Fig. 2 is a partially exploded perspective view of an optical module including a hermetically sealed optical fiber insert structure;

Fig. 3 is a sectional view of the structure along line A-A of Fig. 2; and

Fig. 4 is a sectional view of a pipe member according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Fig. 2 shows the entirety of an optical module with a structure according to an embodiment of the invention. An optical element 13 is installed in a package 14 and optically coupled with terminal 11 at an inserted end of an externally extending optical fiber. An optical connector 12 is coupled to an external end of the optical fiber. The insertion of the fiber to the package 14 is effected through a pipe member 6 provided through an outside wall 7 of a container box 14a of the package 14. The pipe member 6 is hermetically YAG ($Y_3Al_5O_{12}$) welded to the wall 7. A lid 15 is seam welded onto the box 14a in a nitrogen atmosphere. An inserted length of the optical fiber, as well as the optical element 13 inside the package 14, is sealed airtight to the outside of the package 14.

[0016] Fig. 3 shows a sectional view along line A-A of Fig. 2. With reference to Fig. 3, the airtight-sealed optical fiber insert structure will be described along with a fabrication process thereof.

[0017] The optical fiber initially comprises a jacketted fiber 2 consisting of a bare fiber 1 and an insulator 2a covering it. Along a corresponding length to the inserted length, the jacketted fiber 2 is stripped of the insulator 2a to have the bare fiber 1 exposed. The bare fiber 1 thus stripped is dipped in a solder to have a solder coating 3 of a thickness ranging from several μm to dozen μm. The fiber 1 coated with the solder 3 is inserted through a gold plated right inside region 61 of the pipe member 6 so that a cut end of the insulator 2a comes near a longitudinally central point of the pipe member 6 and the jacketted fiber 2 is fitted in a left inside region 62 of the member 6. A solder 4 is let into a gap between the bare fiber 1 and the right inside region 61 of the pipe member 6 from the right end, and is heated to be melted by measures such as a high-frequency heating, so that the fiber 1 is hermetically fixed to the pipe member 6.

[0018] The jacketted fiber 2 is fixed to the left inside region 62 of the pipe member 6, with an adhesive 51 filled therebetween, covering a boundary region 16 of the fiber 1 between the cut end of the insulator 2a and a left end of the solder 4. The adhesive 51 is relatively flexible to deform to absorb undue stresses. The boundary region 16 may be coated beforehand with a UV resin or an equivalent material to have an improved anti-stress nature. The terminal 11 is coupled to the end of an extension of the bare fiber 1, for a connection to the optical element 13. The optical connector 12 is coupled at the end of the jacketted fiber 2.

[0019] The optical fiber hermetically fixed in the pipe member 6 and coupled with the terminal 11 and the optical connector 12 is called "pigtail." The terminal 11 has a smaller outside dimension than an outside diameter of the pipe member 6. Associated parameters such as an insert loss and a quench ratio of the pigtail are measured to ensure conformity.

[0020] The pigtail is inserted into the through hole 9 of the package wall 7, so that the bare fiber 1 extends inside the box 14a, with the terminal 11 leading at an established relative position to the optical element 13 or to the package 14, the terminal 11 is fixed to the optical element 13 . The pipe member 6 is then hermetically fixed to the package wall 7 by a welding 8 along the whole circumferential length of the through hole 9, using a YAG (yttrium-aluminium-garnet) laser beam. An associated outside region of the pipe member 6 as well as an inside diameter region of the through hole 9 is processed in advance, with a small clearance and a low surface roughness.

[0021] Fig. 4 shows a longitudinal sectional view of a pipe member 60 according to an embodiment of the present invention, in which the pipe member 60 has a double tube structure. For a YAG welding between the pipe member 60 and a circumference of a through hole, associated parts are made of selected materials, e.g. stainless steel, Covar, etc. A low carbon stainless steel may preferably be used as a base for the welding. The pipe member 60 comprises an inner pipe 60a made of a Fe-Ni-Co alloy with a linear expansion coefficient of approximately $50 \times 10^{-7} K^{-1}$, substantially equivalent to that of a glass material for optical fibers, with an adapted tendency to absorb thermal stresses, and an outer pipe 60b made of a stainless steel. Ther inner and outer pipes 60a, 60b are fixed to each other by a welding 60c at either or both ends thereof.

[0022] A hermetic sealing is achieved, with a YAG welding 8 between a pipe member 6 or 60 and a circumference of a through hole 9, without using a conventional fixing ring while securing a relatively high hermeticity through simple a facilicated fabrication process.

[0023] Further, a boundary region 16 between a jacketted fiber 2 fixed with an adhesive 51 and a bare fiber 1 fixed by a welding 4 is coated in advance, with a UV resin flexible to absorb mechanical stresses, thus preventing breakage, assuring a long service life.

[0024] While the present invention has been described with reference to the particular illustrative embodiment, it is not to be restricted by them but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope of the present invention.

Claims

1. A hermetically sealed optical fiber insert assembly suitable for being connected to an opto-electronic module by welding in a through hole (9) in an outside wall (7) of a package member (14) thereof,

   said assembly comprising:
   a pipe member (6); and
   an optical fiber inserted in the pipe member (6), the optical fiber including a jacketted part (2) in which the bare fiber (1) is jacketted with an insulator (2a), and a stripped part in which the bare fiber (1) is stripped of the insulator (2a),
   wherein the stripped part (1) is fitted in and soldered to a first inside region (61) of the pipe member (6) with a solder (4) filled therebetween, and the jacketted part (2) is fitted in and fixed to a second inside region (62) of the pipe member (6) with an adhesive (61) filled therebetween,

   characterized in that

   said pipe member comprises an outer pipe (60a) made of a metal suitable for welding, and an inner pipe (60b) made of a metal having a linear expansion coefficent substantially equivalent to that of the glass of the optical fiber;
   the boundary region (16) between the jacketted part (2) and the stripped part (1) of the optical fiber is coated with a resin having flexibility to absorb mechanical stress,
   and said adhesive (51) filled between the jacketted part (2) and the pipe member (6) extends over said boundary region (16).

2. An optical fiber insert assembly according to claim 1, wherein said resin is a UV resin.

3. An optical fiber insert assembly according to claim 1, wherein the metal of said inner pipe (60b) is a Fe-Ni-Co alloy.

4. An optical fiber insert assembly according to claim 1, wherein the metal of said outer pipe (60a) is a low carbon stainless steel.

5. An optical fiber insert assembly according to claim 1, wherein the end of the stripped part (1) of the optical fiber extending beyond said pipe member (6) is coupled to a terminal (11) having a smaller outside dimension than the outside diameter of the pipe member (6).

6. A hermetically sealed optical fiber insert structure incorporating an optical fiber assembly according to one claims 1 to 5, comprising:
   a package (14) housing an opto-electronic device (13) and having a through hole (9) formed in a wall (7) thereof, wherein:
   the pipe (6) is inserted in the through hole (9) and fixed to the wall (7) by a welding (8) along the circumference of the through hole (9).

Patentansprüche

1. Hermetisch verschlossene Einsatzanordnung für eine optische Faser, geeignet zur Verbindung mit einem opto-elektronischen Modul durch Einschweißen in einem Durchgangsloch (9) in einer Außenwand (7) eines Gehäuseelements (14) desselben,

   wobei die Anordnung umfaßt:
   ein Rohrelement (6);
   eine in das Rohrelement (6) eingeführte optische Faser, die einen ummantelten Teil (2), in welchem die bloße Faser (1) mit einem Isolator (2a) ummantelt ist, und einen freigelegten Teil aufweist, in welchem der Isolator (2a) von der bloßen Faser (1) abgestreift ist,
   wobei der freigelegte Teil (1) in einen ersten Innenbereich (61) des Rohrelements (6) eingepaßt und mit einem dazwischen eingeführten Lot (4) verlötet ist, und der ummantelte Teil (2) in einen zweiten Innenbereich (62) des Rohrelements (6) eingepaßt und mit einem dazwischen eingefüllten Klebstoff (61) fixiert ist,

   dadurch **gekennzeichnet**,

   daß das Rohrelement ein äußeres Rohr (60a) aus einem zum Schweißen geeigneten Metall und ein inneres Rohr (60b) umfaßt, das aus einem Metall besteht, dessen linearer Ausdehnungskoeffizient im wesentlichen äquivalent zu dem des Glases der optischen Faser ist;
   daß der Grenzbereich (16) zwischen dem ummantelten Teil (2) und dem freigelegten Teil (1) der optischen Faser mit einem Harz beschichtet ist, das Flexibilität zum Absorbieren von mechanischen Spannungen aufweist,
   und daß der zwischen dem ummantelten Teil (2) und dem Rohrelement (6) eingefüllte Klebstoff (51) sich über den Grenzbereich (16) erstreckt.

2. Einsatzanordnung für optische Faser nach Anspruch 1, bei dem das Harz ein UV-Harz ist.

3. Einsatzanordnung für optische Faser nach Anspruch 1, bei dem das Metall des Innenrohres (60b) eine Fe-Ni-Co-Legierung ist.

4. Einsatzanordnung für optische Faser nach An-

spruch 1, bei dem das Metall des Außenrohres (60a) ein niedrig gekohlter Edelstahl ist.

5. Einsatzanordnung für optische Faser nach Anspruch 1, bei dem das sich über das Rohrelement (6) hinaus erstrekkende Ende des freigelegten Teils (1) der optischen Faser mit einem Anschlußteil (11) gekoppelt ist, das eine kleinere Außenabmessung als der Außendurchmesser des Rohrelementes (6) hat.

6. Hermetisch verschlossene Einsatzstruktur für optische Faser mit einer optischen Faseranordnung nach einem der Ansprüche 1 bis 5, umfassend:

ein Gehäuse (14), das eine optoelektronische Einrichtung (13) umgibt und ein Durchgangsloch (9) in einer Wand (7) desselben aufweist, wobei
das Rohr (6) durch das Durchgangsloch (9) eingesetzt und an der Wand (7) durch Schweißen (8) längs des Umfangs des Durchgangslochs (9) fixiert ist.

Revendications

1. Ensemble d'insertion de fibre optique fermé hermétiquement adapté pour être connecté à un module optoélectronique par soudure dans un trou traversant (9) dans une paroi extérieure (7) d'un élément de boîtier (14) de celui-ci,
ledit ensemble comportant :

un élément de tube (6), et
une fibre optique insérée dans l'élément de tube (6), la fibre optique comportant une partie enveloppée (2), dans laquelle une fibre nue (1) est enveloppée d'un isolant (2a), et une partie dénudée dans laquelle la fibre nue (1) est dépourvue de l'isolant (2a),
dans lequel la partie dénudée (1) est ajustée dans une première région intérieure (61) de l'élément de tube (6) et soudée à celle-ci à l'aide d'une soudure (4) remplie entre celles-ci, et la partie enveloppée (2) est ajustée et fixée dans une seconde région intérieure (62) de l'élément de tube (6) à l'aide d'un adhésif (61) rempli entre celles-ci,

caractérisé en ce que

ledit élément de tube comporte un tube extérieur (60a) constitué d'un métal adapté pour une soudure, et un tube intérieur (60b) constitué d'un métal ayant un coefficient de dilatation linéaire pratiquement équivalent à celui du verre de la fibre optique,

la région frontière (16) entre la partie enveloppée (2) et la partie dénudée (1) de la fibre optique est revêtue d'une résine ayant une souplesse pour absorber une force mécanique,
et ledit adhésif (51) rempli entre la partie enveloppée (2) et l'élément de tube (6) s'étend sur ladite région frontière (16).

2. Ensemble d'insertion de fibre optique selon la revendication 1, dans lequel ladite résine est une résine durcissable aux UV.

3. Ensemble d'insertion de fibre optique selon la revendication 1, dans lequel le métal dudit tube intérieur (60b) est un alliage de Fe-Ni-Co.

4. Ensemble d'insertion de fibre optique selon la revendication 1, dans lequel le métal dudit tube extérieur (60a) est un acier inoxydable à faible teneur en carbone.

5. Ensemble d'insertion de fibre optique selon la revendication 1, dans lequel l'extrémité de la partie dénudée (1) de la fibre optique s'étendant au-delà dudit élément de tube (6) est couplée à une borne (11) ayant une dimension extérieure plus petite que le diamètre extérieur de l'élément de tube (6).

6. Structure d'insertion de fibre optique scellée hermétiquement incorporant un ensemble de fibre optique selon l'une quelconque des revendications 1 à 5, comportant :

un boîtier (14) enfermant un dispositif optoélectronique (13) et ayant un trou traversant (9) formé dans une paroi (7) de celui-ci, dans lequel :
le tube (6) est inséré dans le trou traversant (9) et est fixé à la paroi (7) par une soudure (8) le long de la circonférence du trou traversant (9).

FIG. 1
PRIOR ART

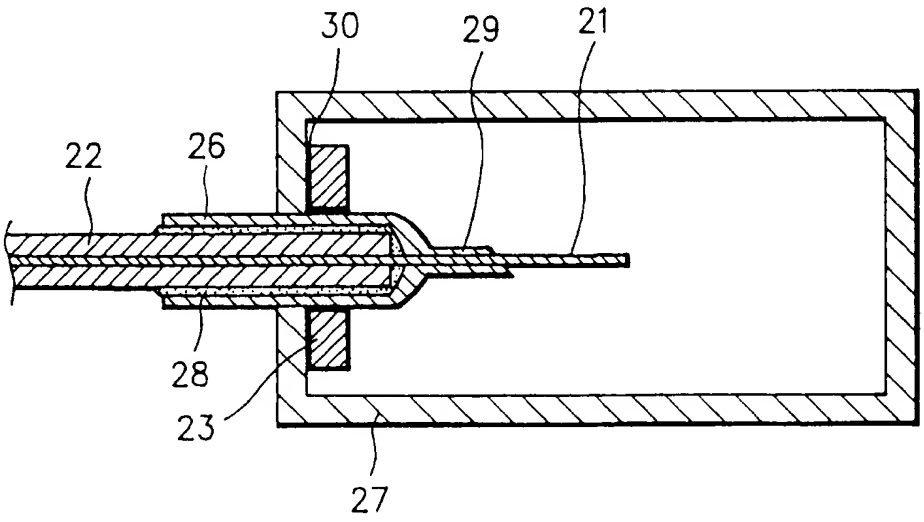

FIG. 2

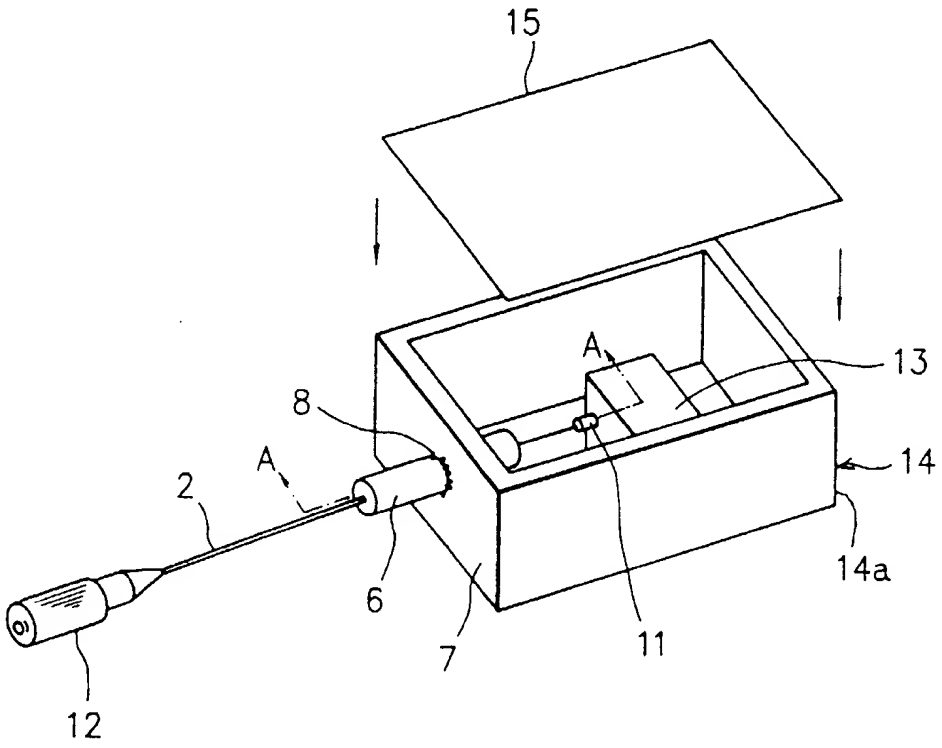

FIG. 3

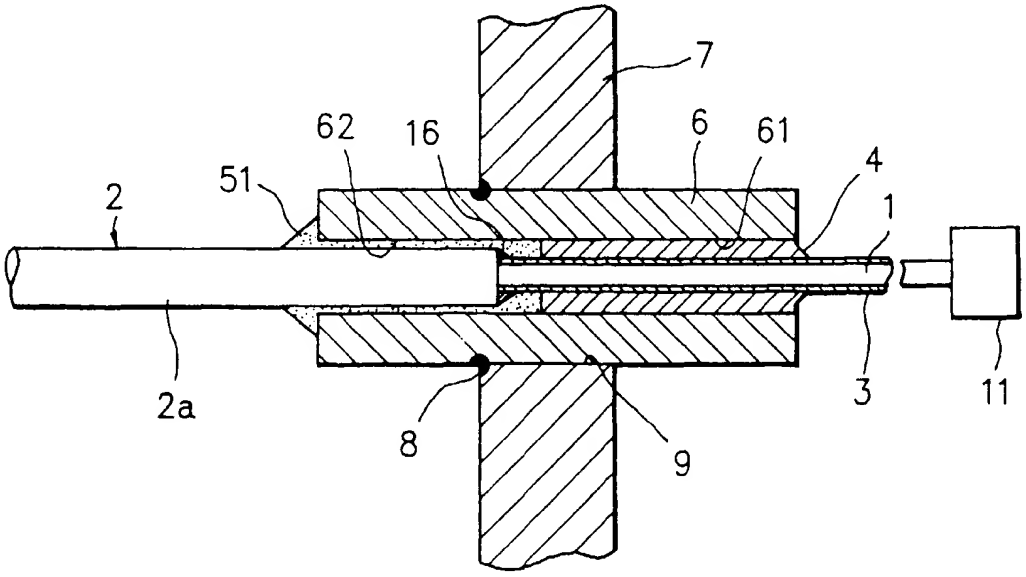

FIG. 4